BULLETIN

OF THE

Society for the Promotion of Engineering Education

Vol. II LANCASTER, PA., OCTOBER, 1911 No. 2

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EDITORIALS.

The Conservation Congress.—It is fitting that the Society should have been represented at the recent National Conservation Congress, because teachers and engineers interested in technical education can, through the colleges, spread most efficiently the interest in the conservation of our national resources. The leading scientific and technical societies have

their "conservation committees" and through them are doing good work for conservation. This fall, recognizing the importance of coöperation between the government and the technical societies, the American Institute of Electrical Engineers has merged all work of a public nature and has turned it over to a new committee on public policy. If our students emerge from college imbued with a broad, unselfish view of their relations to the public, they will be better prepared to enter the highest engineering fields.

The Reports of the Treasurer and the Secretary.—A comparison of the Society's financial statements of ten years ago and today shows a remarkable increase in the amount of money which the Treasurer has to handle. The amount will be further increased this year through the enlarged membership and the increased dues. In order to handle this money efficiently the Treasurer has put the book-keeping on a strictly modern basis by opening, this fall, a complete equipment of double-entry books. These are in charge of a first-class bookkeeper. The Society is fortunate in having at its disposal, practically without expense, the facilities of an up-to-date business office. A study of the Secretary's report shows that the past year has been remarkable in the accession of non-teaching engineers to the membership. This is largely due to the coöperation of the engineers in the membership committee, who carefully selected a list of men who are interested in technical education and who, if secured as members, would greatly strengthen the organization. The invitations extended in the name of the membership committee were well received, as the results indicate. Another feature of interest in the Secretary's report is the statement of the assistance rendered by the advertisers in supporting the BULLETIN. We all realize that business firms are besieged with requests for advertisements and that they must select carefully to get efficiency in their expenditure. They are properly wary of a new venture in periodical literature. In the case of the BULLETIN the advertising space appeals only to

publishers and to makers of laboratory and field supplies and apparatus, hence we are very fortunate in having found so many firms willing to assist in establishing the BULLETIN. Without this assistance its publication would be impossible.

The Teaching of Dynamics.—The Committee on the Teaching of Mathematics to Engineering Students at first intended to include a section on dynamics in the report recently presented to the Society. It was found, however, that in the available time it would be impossible to secure sufficient agreement among the members as to what the section should comprise. In accepting the report, the Pittsburgh meeting requested the Committee to bring in a report on the subject next year. In the meantime the chairman* will be pleased to receive expressions of the views of the members along this line. The first communication is printed in this issue of the BULLETIN.

New Fields in Technical Instruction.—Chemical engineering and highway engineering are two of the new branches of technical instruction which are being carefully investigated at the present time. Professor James's paper, treating of the former subject, should be studied in connection with one by Dean C. H. Benjamin, printed in the June BULLETIN. Dean Benjamin has collected valuable data showing current practice in the training of chemical engineers, while Professor James outlines the conditions which have brought about the necessity for the creation of the new profession. In the field of highway engineering the inception of the new graduate course at Columbia indicates progress. The Society was fortunate in having, at the New York meeting, an address from Director L. W. Page, of the Office of Public Roads, United States Department of Agriculture. He outlined the essentials of a highway engineering course and emphasized the importance of the subject. Professor Blanchard has followed Mr. Page's suggestions and has planned a course which

*Professor E. V. Huntington, 27 Everett St., Cambridge, Mass.

fits in well with the peculiar time schedule of highway engineering. A report from him after the plan has had a trial will be of great interest.

Professor Paine's Paper.—Instructors who keep up to date spend much time in visiting institutions other than their own to learn of new ideas and methods and to meet the people back of these. If they can have access to papers like that of Professor Paine and other contributors to the *Proceedings* of this Society they are able to get the most important of the desired information without the expense incident to long trips. The money thus saved can be invested to better advantage in attending conventions where new acquaintances can be made and old ones renewed under delightful conditions.

The Technical Graduate and Business.—An important feature of the Pittsburgh meeting was the discussion of the relation of the technical graduate to the industries. Mr. E. B. Raymond's paper along this line was well received by the members present who appreciated that his experience had been such as to give great weight to his conclusions. In the next issue of the BULLETIN other papers in the same general field will be printed and the group of papers should bring out profitable discussion.

The Teacher's Summer Vacation.—In his presidential address Professor A. N. Talbot pointed out the importance of the proper use of the summer vacation in the instructor's education. During the summer just closed many of our members have been engaged in more or less profitable engineering work. The profit has been made up of several components, such as improved technical preparation for future work, and stimulation through meeting new people and coming in contact with live problems. It is probable that, as a rule, the financial returns have not been satisfactory. On the contrary the extra expense of living away from home may have more than offset the compensation received. The

results, however, probably justified the sacrifice which had to be made. It would be interesting to learn from the members what their experience has been in this direction. The BULLETIN will be pleased to print letters dealing with summer experiences for the benefit of the younger members of the Society.

THE COUNCIL.

In the report of the Nominating Committee, printed in the September BULLETIN, the name of Professor F. L. Emory was omitted from the list of nominations of Council members. It appeared in the report of the Committee and Professor Emory was duly elected.

APPLICANT FOR MEMBERSHIP.

KONDO, TORAGORO, Chief of Technical Division, Home Department, Public Works Bureau, 10 Nichi-katamachi, Komagome, Tokyo, Japan 1911

Mr. Kondo, after graduation from the Imperial University at Tokyo, was engaged in practical work in the United States from 1887 to 1889. Since 1890 he has been an engineer with the above department, first as inspector of all engineering work, except railroads, in six northern provinces, as well as engineer in charge of the Kitakami River improvements for 126 miles. He was next chief examiner of rivers, roads and harbors throughout the country and later took up his present work. He is at present a member of the Earthquake Investigation Committee, of the Tokyo City Improvement Committee, of the Harbors Investigation Committee, etc., as well as lecturer in the Engineering College of the Imperial University. He was sent on government commissions to Java (1896), Europe (1902), Europe and America (1906). Mr. Kondo received the degree Kojaku-hakushi (doctor in applied sciences) from the Minister of Education in 1899 and was decorated with the third order of the Sacred Treasure in 1907. He is a member of the American Society of Civil Engineers.

MEMBERSHIP ITEMS.

Upon the unanimous motion of the engineering faculty, the rector and senate of the Technical University of Darmstadt, Germany, have conferred upon Mr. Wm. Paul Gerhard, author and consulting engineer, and member of this society, the honorary degree of doctor of engineering. The official

document notifying Mr. Gerhard of the honor conferred states that same was given in "appreciation of his prominent position in sanitary engineering and in acknowledgment of his many writings on sanitation and public health by which both theory and practice have been markedly promoted."

Mr. Chas. F. Scott, formerly consulting engineer of the Westinghouse Electric and Manufacturing Company, has taken up his new duties as professor of electrical engineering in the Sheffield Scientific School of Yale University.

The Department of Physics and Electrical Engineering at the Agricultural and Mechanical College of Mississippi, for the past two years under charge of Professor Clarence E. Reid, has been enlarged to two departments.

Associate Professor L. L. Patterson has been made professor of physics, and Mr. H. P. Braeutigam has joined the Department of Electrical Engineering. Mr. Braeutigam is a graduate of Purdue, 1909, and has had two years' apprenticeship work with the Allis Chalmers Manufacturing Company, at Cincinnati and Milwaukee.

CONSERVATION CONGRESS DELEGATION.

President Raymond made the following appointments of delegates to the National Conservation Congress. A report of the Congress and its relation to the work of the Society will be anticipated with pleasure by the membership.

Dean F. O. Marvin, Kansas State University, Lawrence, Kansas; Dean A. Marston, Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa; Professor F. P. Spalding, University of Missouri, Columbia, Missouri; Professor J. L. Van Ornum, Washington University, St. Louis, Missouri; Dr. J. A. L. Waddell, Kansas City, Missouri.

TREASURER'S REPORT, 1910–1911.

To the Society for the Promotion of Engineering Education:

The Treasurer would respectfully report the condition of the Society's finances as follows:

SUMMARY OF RECEIPTS.

June 18, 1910, Cash balance on hand	$ 342.20
July 1, 1910, to June 15, 1911,	
Received for dues, 1911–1912	17.00
Received for dues, 1910–1911	3065.48
Received for dues prior to 1910–1911	283.26
Received for Life Membership	200.00
Received from sale of Proceedings and Bulletin	346.08
Received from authors' reprints	69.72
Received from advertisements in Bulletin, Vol. I	886.90
Received stamps	.25
Received from sale of cuts	6.74
Received from interest on deposit at Lincoln Trust Co., July 1, 1910	12.27
Lincoln Trust Co., January 1, 1911	3.36
	$5,233.26

SUMMARY OF EXPENDITURES.

Postage and sundries for Professor Munroe	$ 14.77
Badges for Madison meeting	16.00
Reporting Madison meeting	81.00
Expenses of Treasurer for printing, postage, etc.	117.13
Collection of out of town checks	7.89
Clerical assistance for Treasurer	75.00
Expenses of Secretary for postage, etc.	193.03
Expenses of Secretary for printing, etc.	317.63
Clerical assistance for Secretary	223.55
Secretary's arrearage on honorarium	150.00
Secretary's current honorarium	400.00
Secretary's allowance for editing and publishing Bulletin	350.00
The New Era Printing Company,	
For printing Bulletin, Vol. I	894.87
For postage, authors' reprints, expressage and sundry printing	361.69
On account for Vol. 18 of the Proceedings	750.00
Professor A. L. Williston for arrearage in honorarium	150.00
Professor A. L. Williston for commission on sale of Proceedings.	125.24
Cash on hand, June 15, 1911	1,005.46
	$5,233.26

ASSETS.

Cash on hand, June 15, 1911	$1,005.46
Dues from members and non-members,	
Dues	701.50
Advertisers	184.00
Proceedings, Bulletins and Reprints	191.11
3,147 Vols. of Proceedings on hand, valued at $1.00 each	3,147.00
	$5,229.07

LIABILITIES.

The New Era Printing Co., bill of March 18, 1911, for printing Vol. I, No. 9, of Bulletin	$ 116.70
Balance due on New Era Printing Company's bill of April 29, 1911, for printing Vol. 18 of the Proceedings	356.33
	473.03
Net assets	$4,756.04

The total amount due the Society is $1,076.61 as compared with $669.62 last year. There are 76 members one year in arrears; 29, two years; 12, three years; and 9, four years. The total arrearage in membership-years is $(76 \times 1) + (29 \times 2) + (12 \times 3) + (9 \times 4) = 206$. The corresponding number last year was 166.

Respectfully submitted,

WILLIAM O. WILEY,
Treasurer.

SECRETARY'S REPORT, 1910–1911.

To the Society for the Promotion of Engineering Education:

The work of the Secretary's department during the past year has comprised the following divisions:

a. Editing the Proceedings of the Society.

b. Publishing the Proceedings.

c. Maintaining a correct roll of members with addresses and publishing the same.

d. Conducting a continuous membership campaign.

e. Editing the Bulletin.

f. Publishing the Bulletin.

g. Miscellaneous correspondence.

h. Filing and arranging the Society's records.

PROCEEDINGS.

With the sanction of the Council the membership list was omitted from the Proceedings this year and the size of the volume was thus

kept down. In addition the weight of paper was reduced for the same purpose. The size of type had been reduced the previous year. As a result the volume has been kept of convenient size although the amount of material contained is much greater than that of any preceding, except 1907. Many valuable contributions to the discussion were obtained after the meeting by means of the publication of papers in the Bulletin.

The publication of the Proceedings involved, among other items, an advertising campaign. All of the important libraries, about 1,100 in number, were notified of the appearance of the volume and a number of copies were sold. The sale of back volumes to members and others also was continued and with the sale of the current volume to outsiders formed a satisfactory source of income. In spite of the large sale, however, the total stock is much larger than last year. A large stock has been kept at the Secretary's office, but the main storage is at the printer's at Lancaster, Pa. The stock is fully insured.

Membership.

The gross increase of membership during the year has amounted to 211 (see appendix) exclusive of a long list of applications to be acted upon at the meeting. A very small number of resignations were received, but the Council will be obliged to drop a score or more for nonpayment of dues. The Secretary has been assisted in this work by a large membership committee with representatives from several different professions. Several members of the committee have renderd much assistance. By means of form and personal letters several thousand persons have been invited to join during the year. The membership passed the "1,000-mark" about March 1st. A number of members not on the membership committee have sent in applications. Their help has been greatly appreciated.

Bulletin.

The editorial work has consisted in securing news of the colleges, in arranging the papers for publication, etc. A number of members agreed to act as correspondents and these have sent in numerous interesting news and other items.

The publication work has been greater than the editorial. Securing advertising support has presented some difficulties as advertisers are wary regarding new publications. Several advertisers, however, have stood by loyally and others are taking hold. Tables showing the record of the year's advertising are given in an appendix.

Other Matters.

During the year the various records of the Society have been gone over and all useless matter eliminated. An accession list of members

from the beginning has been prepared with as accurate a record of withdrawals as it has been possible to make. Sectional filing cabinets of modern design have been procured and the property of the Society has been arranged for ready reference. A large room at the Secretary's residence has been fitted up for the Society's use and a stenographer is continuously employed in the many activities of the Society.

The correspondence involves the keeping in touch with other societies and the press, the arranging of details for the program and other committees, etc.

Respectfully submitted,
HENRY H. NORRIS,
Secretary.

APPENDIX TO SECRETARY'S REPORT.

NEW MEMBERS.

Elected by letter ballot, September 1, 1910: M. A. de Chatelain, R. H. Fisher, Frank Koester. (3.)

Elected by letter ballot, October 30, 1910: L. E. Akeley, W. E. Barlow, P. L. Beam, J. A. Bensel, W. H. Breithaupt, A. M. Buck, C. S. Burns, H. J. Burt, I. P. Church, W. W. Colpitts, M. L. Cooke, P. H. Daggett, E. A. Gibbs, A. J. Gibson, Henry Goldmark, J. C. Hallsted, L. A. Hazeltine, W. O. Henderer, E. G. Hoefer, R. P. Iyer, E. S. Jarrett, Phelps Johnson, J. E. Kaulfuss, H. G. Kelley, H. H. McClintic, D. W. McNaugher, Leonard Metcalf, J. C. Ralston, W. H. Rasche, H. A. Sayre, J. D. Schuyler, H. W. Smith, J. F. Stevens, G. W. Stewart, Gustav Wittig, P. L. Wolfel, S. M. Woodward. (37.)

Elected by letter ballot, November 25, 1910: F. L. Bixby, J. N. Bryant, W. H. Burger, W. L. Church, W. W. Curtis, N. B. Garver, M. W. Haskell, H. C. Kendall, F. W. Marquis, C. E. Noerenberg, G. W. Pickels, Jr., J. N. Vedder, O. E. Williams. (13.)

Elected by letter ballot, November 30, 1910: A. A. Adler, Wm. W. Bird, Geo. L. Brown, L. W. Chase, E. F. Church, Jr., Enrique Cruchaga Ossa, F. M. Dawson, L. M. Dennis, J. F. H. Douglas, R. J. Fogg, F. S. Foote, Sr., H. W. Heidenger, J. C. Hubbard, Chas. Jablow, A. J. Jobson, A. R. Keller, J. A. Lahmer, J. F. LeBaron, Jacob Lund, Jas. C. Lund, F. C. Miller, H. E. Murdock, F. Y. Parker, W. S. Payne, J. E. Rasmusen, J. J. Richey, F. K. Richtmyer, A. A. Robinson, L. A. Scipio, E. C. Shankland, P. K. Slaymaker, J. E. Smith, R. K. Steward, Chas. L. Walker, A. E. White, Paul Willis, H. C. Woods. (37.)

Elected by letter ballot, December 13, 1910: G. G. Anderson, G. F. Blessing, A. W. Browne, J. T. Buser, T. C. du Pont, Isami Hiroi, H. E. Marsh, F. A. Molby, Richard Morris, J. L. Morse, J. C. Parker,

G. C. Priester, A. C. Prime, D. B. Steinman, S. A. Stephenson, Jr., T. L. Sturges, Jr., A. J. Wurts. (17.)

Elected by letter ballot, December 31, 1910: F. A. Berger, F. C. Bolton, A. C. Callen, G. W. Lamke, Chas. McGonigle, B. L. Miller, Everett Norss, C. W. Nichols, M. R. Richardson, W. J. Risley, L. K. Russell, E. O. Sweetser. (12.)

Elected by letter ballot, February 25, 1911: H. Berents, A. R. Crathorne, W. W. Crosby, F. W. Durkee, J. B. Frear, F. J. Kircher, J. J. Long, F. M. Mann, W. K. Monroe, E. B. Paine, C. W. Parks, J. A. Randall, Alfred Raymond, W. J. Raymond, H. L. Reitz, W. I. Slichter, H. C. Van Buskirk. (17.)

Elected by letter ballot, April 13, 1911: A. W. Berresford, J. C. Bland, L. F. Blume, C. C. Chesney, C. A. Coffin, C. W. Converse, E. L. Coster, Gano Dunn, A. J. Frith, L. H. Fry, Henry Gardner, F. A. Geier, W. P. Gerhard, J. F. Gilchrist, C. R. Grimm, C. T. Hagerty, W. J. Harahan, Henry Hess, T. S. Hewerdine, C. W. Hunt, E. P. Hyde, B. F. Lovelace, G. W. McCoard, C. T. Main, W. D. Marks, S. A. Moss, J. E. Muhlfeld, Willard Pope, E. L. Powers, A. B. Smith, F. H. Stillman, C. L. von Ende, G. A. Wells, Jas. G. White. (34.)

Elected by letter ballot, May 17, 1911: E. H. Beckstrand, R. H. Bradford, W. A. Bratton, Andrew Carnegie, H. H. Carroll, S. B. Charters, Jr., Paul Cloke, Chas. Day, J. A. Dent, P. M. Dysart, E. S. Foster, J. L. Gibson, Rudolph Hering, T. P. Holt, L. L. Hubbard, G. H. Hunt, G. A. Kelsall, R. B. Ketchum, A. A. Knowlton, F. W. Lane, P. M. Lincoln, F. M. McGaw, G. E. Molleson, Dalton Moomaw, Chace Newman, A. M. Ockerblad, L. A. Osborne, F. J. Pack, B. K. Philp, O. B. Poore, A. S. Rosing, W. T. Ryan, A. R. Sage, J. E. Shaw, H. G. Stott, H. R. Thayer, Chas. H. Tower, Wm. S. Turner, David Van Alstyne, J. M. Weed, Edw. Weston. (41.)

ADVERTISING IN BULLETIN, VOL. I.

Advertiser.	Amount.
Chicago Book Company	$ 5.00
Eugene Dietzgen Company	20.00
Electrical Review and Western Electrician	30.00
Engineering News Publishing Company	164.00
Esterline Company	10.00
General Electric Company	10.00
Ginn & Company	13.00
Henry Holt & Company	35.00
Leeds & Northrup Company	50.00
J. B. Lippincott Company	20.00
A. C. McClurg & Company	15.00
McGraw-Hill Book Company	128.00

Advertiser.	Amount.
McGraw Publishing Company	125.00
G. S. Moler	5.00
New Era Printing Company	50.00
Trautwine Company	10.00
D. Van Nostrand Company	43.00
W. & N. Publishing Company	5.00
Westinghouse Electric & Mfg. Company	10.00
Weston Electrical Instrument Company	43.00
John Wiley & Sons	205.00
Total	$996.00

ADVERTISING BY MONTHS.

Month.	Amount.
September	$ 95.00
October	102.00
November	97.00
December	85.00
January	82.00
February	97.00
March	97.00
April	102.00
May	97.00
June	142.00
Total	$996.00

COMMITTEE ON INDUSTRIAL EDUCATION.

To the President and Members of the Society:

The Committee on Industrial Education makes no formal report this year. Its first report was made eleven years ago, and several reports have been made since, of work in progress and of work achieved. While the opinions of my associates have not been asked in the matter, it seems to me that the special work which the committee was expected to do has been finished to the best of the committee's ability, and that there is no sufficient reason now for its continuance.

A very important and far-reaching change in elementary education has taken place, through the introduction of what has variously been called manual training, industrial training, vocational training, elementary technical training, mechanic art, household art, handicraft, etc., and the principles involved no longer need explanation, nor does the public require that its value shall be set forth by any committee of this society. I therefore suggest that the Committee on Industrial Education be excused from making any formal report this year, and that it now be discharged.

The reports of the Commissioner of Education show the extent to which the new features have entered into American school education, and the movements on foot for its extension into various industrial fields. Conspicuous in the latest movement are the arrangements making all through the country for thorough training in the science and art of the cultivation of the soil on farms, in orchards and gardens. East and west, north and south, boys and girls, both white and black, are being sent to the farms.

In our great cities most elaborate and expensive facilities are offered for the training of every boy and girl in the public schools.

If I briefly describe what has been done in the city of St.

Louis since our committee was appointed, I shall only describe what has been done, to a greater or less degree, in other cities; and I may say now, once for all, that what has been done in the United States has been strictly original and American in character. We have not copied what has been done in other lands, and there is no evident intention of copying from any country. To be sure, we have seen what has been going on elsewhere, and we have seen how differently they have solved their problems from the way in which we have solved ours. Their problems are really different, and naturally their solutions are different. While the experience and reports of foreign educators have been valuable and full of suggestion, they have probably strengthened us in our feeling of confidence in our own methods.

During the last fourteen years, I have been a member of the Board of Education in St. Louis. Twelve years ago the board took up in a tentative way manual training and domestic science. The work grew in its hands from year to year, and at the present time every boy and every girl has manual training (in which is included the mechanic arts, household arts, free-hand and mechanical drawing) from the seventh grade to the twelfth grade inclusive throughout the city. In the seventh and eighth grades the work is required. In the high school grades it is open to choice, but the enrollment of the graduating classes shows that the so-called manual training course has a plurality of the members.

Every high school is admirably equipped for both boys and girls throughout the four-year course. This account covers both the white schools and colored schools. In the colored high school a special feature of the manual training course for boys and young men includes a thorough theoretical and practical study of the modern automobile with a view to making every graduate a competent chauffeur. He understands every detail of the construction of the gasoline motor, and just how every adjustment is made. To facilitate this work, two up-to-date machines are a part of the laboratory

equipment, and these machines are taken apart, are re-assembled, adjusted, and operated in the streets of the city, under the care of skillful teachers. It is almost needless to add that the graduates of the Charles Sumner High School find ready and satisfactory occupation in this city.

Conspicuous among the results of this introduction of manual training into the public schools has been the unprecedented interest in high school education. The high school attendance has increased three times as fast as the city has grown in population, and the end is not yet. The board is almost embarrassed by the increasing demand for high school facilities.

Fortunately, the people of the city and the state are well disposed towards thorough educational training, and the board has been able thus far to meet the demands as they have arisen.

I do not know that St. Louis has done better than other cities, but certainly the situation today, as compared with the situation when this committee was called into being, indicates the remarkable change in the content and method of the education of our youth. The attitude of the leaders of education on all sides makes it increasingly evident that our committee has no further reason for existence, and that it may "without prejudice" very properly be discharged.

I submit this letter not as a report of the committee, but as containing my personal views and wishes.

Respectfully,

CALVIN M. WOODWARD.

TWENTY-FIFTH ANNIVERSARY OF THE MICHIGAN COLLEGE OF MINES.

BY PROFESSOR F. W. SPERR.

The celebration of the twenty-fifth anniversary of the Michigan College of Mines and first reunion of the alumni came to a close Friday evening, August 11, when a brilliant boat parade was held on Portage Lake. All who took part in the celebration have pronounced it very successful. As a result alumni reunions will probably be held hereafter every five years, in accordance with the plan of Mr. Wm. Kelly, chairman of the Board of Control.

The program of the occasion combined instruction with pleasure. It was opened Tuesday morning when Governor Osborn and Secretary Nagel reviewed the parade of infantry, naval reserves and former and present students, on College Avenue. The afternoon exercises of Tuesday and Wednesday were held in the large auditorium tent on the college campus. A band concert by the Calumet and Hecla band was given on each of these days and then followed the speeches. On Tuesday Governor Osborn, Secretary Nagel and Mr. J. Parke Channing were the speakers and President Drinker and Dr. George Otis Smith spoke Wednesday. Mr. George W. Perkins was unable to be present at the celebration, but sent the address he was scheduled to give and it was read Wednesday afternoon by President McNair. Concerts by Hess and Pasquali were enjoyed in the evenings of these two days.

A dinner for alumni, instructors, the Board of Control and guests, at which some 400 persons were present, was given Tuesday evening. On Wednesday morning in the auditorium tent the alumni gathered and effected the organization of a new Alumni Association with John L. Harris for President, E. W. Walker, Vice President, and Ben Sparks, Treasurer. After the speeches in the afternoon, President and Mrs. Mc-

Nair gave an informal reception to the alumni and former students. The closing feature of the day's program was a nightshirt parade of the students led by the Calumet and Hecla band.

Thursday and Friday were occupied with excursions to the mines, mills and smelters. A party of 150 went north on Thursday. At Lake Linden they visited the power plant, the Hecla mill, the wheel for elevating sands, and the recrushing plant with which the Calumet and Hecla is working over some of its old sands. The party then continued to Gay where the belt system of handling tailings was observed in the Mohawk and Wolverine mills. Returning, a stop was made at Ahmeek to see the concrete square sets and lagging in use there for lining the shafts; and at Calumet to visit the Red Jacket shaft with its eight-ton Kimberly skip and special rock-handling devices. About the same number were taken out on the Copper Range on Friday. Many of the party went underground at the Champion mine to observe the dry wall system of stoping. The Baltic mill and its steel-concrete dam at Redridge were visited. Lunch was taken at Freda and a stop was made at the Michigan Smelter on the way back to Houghton.

"In Tobero," a musical comedy, was presented to a full house in Kerredge Theatre Thursday evening by the students. The events of Friday evening, the last of the celebration, included, besides the boat parade, a dance by the students in the gymnasium and a dinner to ex-President Wadsworth by those who had studied under him during the twelve years he was head of the institution.

Some of the addresses given during the celebration have excited wide comment. This is especially so of those given by Secretary Nagel and Mr. George W. Perkins. Those by Dr. Drinker of Lehigh and Dr. George Otis Smith (Director of the United States Geological Survey) were of equal force but of more technical nature. It is noteworthy that each of these speakers touched upon the relation of the business and the

development of the country, although none of them had previous knowledge of the topic on which any of the others was to speak. Their views largely coincided. Secretary Nagel's speech was a plea against destructive radicalism. He would have all sections of the country get together and work out a constructive business policy which would define the powers of the large corporations positively. Also he would like to have the Commerce Department more highly developed to assist those who carry on the business of the country. "Wanted: A Constructive National Policy" is the title of the address which George W. Perkins forwarded to be read at the reunion. Mr. Perkins advocated corporate publicity as a chief means of doing away with the wrongs which have arisen through the growth of large business units. He would have the national government undertake the supervision of the large corporations.

President Drinker of Lehigh spoke on "The Contribution of the Mining Engineer to Conservation." He recounted the history of the American Institute of Mining Engineers' work in investigating methods of economic coal mining. It had been found, he said, that large units were necessary to develop mineral resources without waste, and he supported the contention with quotations from the findings of the institute and the Geological Survey. He desired that engineers should take a greater interest in conservation as it is a question for them to solve and "It is dangerous for a man untrained in engineering to venture opinions on such a question as the conservation of coal." He pointed out that this generation should use all that it needs without waste, but without worrying about the next which may have substitutes. Dr. George Otis Smith, Director of the United States Geological Survey, told of the relation of "The Mining Industry and the Public Lands." He spoke of the present work of his department in classifying the public lands according to their mineral, forest or agricultural character. This work is a step toward allowing their proper development. He urged that new laws gov-

erning the acquirement of the public lands should be made with a view to permitting their development and preventing their being held for mere speculative purposes.

J. Parke Channing spoke on the "Beginning of the Michigan College of Mines." The suggestion of such a college had come from him and he was especially fitted to outline its history and to make suggestions for its future. He pointed out that when Michigan established its mining school at Houghton it recognized the necessity and advantage of having such a school in a mining district, as did Germany when it established its School of Mines at Freiberg and also at Clausthal. And he made a strong plea for adequate financial support of the institution by the state which derives much of its revenue from the mines both directly and indirectly. Mr. Channing with equal significance pointed out the advantage the college enjoys from the fact that all the members of its Board of Control are mining men.

That the Michigan College of Mines is not only a local institution was emphasized by the attendance at the celebration. President Taft had accepted an invitation to be present but, not being able to come, sent Secretary Nagel as his representative. All the speakers have a national reputation. Other noted men present were Prof. A. E. Haynes of the University of Minnesota; Dr. Horace V. Winchell, Geologist of the Great Northern Railroad; Dr. W. R. Ingalls, Editor of the Engineering and Mining Journal; Dr. R. H. Richards of the Massachusetts Institute of Technology; Mr. T. F. Cole of Duluth and many other successful mining men.

Mr. Kelly's plan of holding a reunion has worked out so well that the alumni and friends of the college will look forward expectantly to the future celebrations. Already a movement is on foot that should insure an even better gathering when the alumni come together five years hence. This is the organization of Michigan College of Mines alumni clubs wherever there are any number of the graduates.

THE TEACHING OF ELEMENTARY DYNAMICS.

BY MR. WILLIAM KENT,
Montclair, N. J.

In recent numbers of the BULLETIN there has been printed the revised report of the Committee on the Teaching of Mathematics to Engineering Students, which committee was appointed at a joint meeting of the American Mathematical Society and Sections A and D of the American Association for the Advancement of Science in December, 1907.

The preliminary report of the committee was presented in the form of galley proofs at the meeting of the Society for the Promotion of Engineering Education at Madison, Wis., in June, 1910. This preliminary report contained a chapter on "Elementary Dynamics," a criticism of which by the present writer was printed in *Science*, May 5, 1911. At the Pittsburgh meeting, in June, 1911, it was announced that the chapter had been withdrawn from the report, as the committee had not been able to agree upon the method of presenting the subject. This action of the committee is in harmony with that of a conference of teachers of physics in 1909, a majority of which signed a statement, "that colleges should require of schools no quantitative treatment of kinetics, or the behavior of matter undergoing acceleration." (See *Science*, October 29 and December 24, 1910.)

The reasons why many teachers find it so difficult to teach dynamics and why conferences of teachers and committees fail to come to an agreement as to the methods of teaching it, have been given at some length by the writer in his two articles in *Science* of October 29, 1909, and May 5, 1911, and it is not necessary to repeat them here. Let us acknowledge the lack of agreement and see if some basis can be found upon

which an agreement may ultimately be founded. There is no difference of opinion as to the fundamental facts of dynamics. Everyone knows that matter is stuff that occupies space and is attracted by the earth's gravitation, and that its quantity can be ascertained by weighing it. Everyone knows that force is either a push or a pull, and that the amount of a force can be ascertained by means of a spring balance. Everyone knows what is meant by the words time and space. Every teacher of physics or mechanics can easily calculate the results which follow the action for a given time of a constant force upon a given quantity of matter which is free to move, and he has definite concepts of velocity, acceleration, momentum, energy, etc. It is only when the teacher attempts to convey his knowledge to the student that he meets with trouble.

In the writer's opinion the difficulty is not due to the facts but only to the language in which the facts are presented. The writers of text books have made the subject obscure by using new forms of words to express their ideas, by inventing new terms, such as the "poundal" and "gee-pound," and by lack of clearness and precision of statement. What is wanted is to put the subject of elementary dynamics into language which can be understood by every high school student, so brief that it can be memorized, scientifically correct, and unencumbered by unnecessary ideas or words.

The following is an attempt to meet this requirement. The writer asks for it the careful attention of teachers of engineering students, and if anyone is disposed to object to it either in gross or in detail, will he kindly write out his own method of presenting the subject for the purpose of comparing it with the writer's method. Constructive criticism is wanted, with the end in view of ultimately finding a form of words which text-book writers will adopt as the form which will most easily give the student the ideas he should have concerning elementary dynamics.

ELEMENTARY DYNAMICS, ENGLISH SYSTEM.

We deal with four things or elementary quantities:

Matter,	W pounds
Force,	F pounds
Time,	T seconds
Space,	S feet

and two derived quantities, velocity, V feet per second, and acceleration, A, the rate of change of velocity, feet per second per second.

Fundamental Statement.—A force F acts during a time T, on matter W, at rest at the beginning of the time, but free to move, and causes it to move during the time T, through a distance S. It is required to find the relations or algebraic equations between the several quantities W, F, T, S, V, A. Thus if a given force F acts on a given quantity of matter W at rest but free to move, what is the velocity V, acquired at the end of that time, what is the acceleration, and what distance does the body move?

I. *Special Case: Falling Bodies.*—F and W are constant and numerically equal; $F = W$. It is found by experiment that a body falling freely (at lat. 45 degrees and the sea level) from a state of rest for one second, acquires by the end of the time a velocity of 32.174 ft. per second. This figure is represented by g.

It is also found that at the end of times

$T =$	1	2	3	4	5 seconds.
The velocity $V =$	g	$2g$	$3g$	$4g$	$5g$ feet per sec.
The space traversed each sec. =	$\frac{1}{2}g$	$\frac{3}{2}g$	$\frac{5}{2}g$	$\frac{7}{2}g$	$\frac{9}{2}g$ feet.
Total space traversed =	$\frac{1}{2}g$	$\frac{4}{2}g$	$\frac{9}{2}g$	$\frac{16}{2}g$	$\frac{25}{2}g$ feet.

If V_1 = the velocity at the beginning of any period of time t and V_2 the velocity at the end of that period, the acceleration

$$A = \frac{V_2 - V_1}{t} = g, \text{ a constant.}$$

Thus let t = the two seconds elapsing between the end of the third and the end of the fifth seconds,

$$\frac{V^2 - V'}{t} = \frac{5g - 3g}{2} = g.$$

Also $A = V/T = g$, V being the velocity at the end of any time T.

From these experimental facts we derive the equations

$$V = gT; \quad S = \tfrac{1}{2}gT^2 = \tfrac{1}{2}VT; \quad V = \frac{2S}{T}; \quad V^2 = 2gS;$$

$$V = \sqrt{2gS}; \quad S = \frac{V^2}{2g}; \quad A = g.$$

W and F do not appear in these equations, but since in the case considered $W = F$, we may multiply (or divide) one side of either of the above equations by W and the other side by F, and they will remain true, thus we obtain

$$FT = \frac{W}{g} V; \quad AW = Fg,$$

whence $F/a = W/g$.

If we substitute the letter M for W/g we have

$$FT = MV : F = MA.$$

II. *General Case.*—F equal to, or greater or less than W,

$$\text{let } a = \text{the acceleration} = > \text{or} < g.$$

It is found by experiment that if W is constant and it is acted on by different forces F_1, F_2, F_3 (at different times), the accelerations produced, a_1, a_2, a_3, are directly proportioned to the forces.

Also if the force is constant, and it acts on different quantities of matter, W_1, W_2, W_3, the accelerations a', a'', a''', are inversely proportional to the Ws.

These two facts are expressed by the formula $a \propto F/W$ which is read: a varies directly as F and indirectly as W.

From algebra we know that the expression $a \propto F/W$ is equivalent to $a = cF/W$, or $aW = cF$, in which c is a constant for all values of F and W.

From falling bodies we have $AW = gF$, therefore the value of c is g, and $aW = gF$ is a general equation for any value of F and the corresponding acceleration produced by F; and since $a = V/T$ we have $FT = MV$, $F = MA$, as in the case of falling bodies.

These equations are therefore general and apply to all cases of the action of a constant force on a body free to move.

The expression $FT = MV$ is sometimes translated "Impulse = momentum," but impulse is merely the product FT and momentum the product MV.

Energy, the capacity for performing work. Work is the product FS (in foot-pounds) of a force into the distance through which it is exerted. If we lift a body of W pounds by applying a force $F = W$, overcoming gravity, through a height S, the work done is $FS = WS$. When held at height the body is said to have potential energy WS. If it now falls through the height S, it acquires a velocity $V = \sqrt{2gs}$ and the body now has kinetic energy, numerically equal to the work done in lifting it, $FS = WS$. Substituting for the last S its value $V^2/2g$ we have $FS = WV^2/2g = \frac{1}{2}MV^2$, the equation of work done and kinetic energy.

Metric System.

In the metric system of weights and measures all the formulæ given above apply just as they do in the English system, but the word "kilograms" is substituted for "pounds" and "meters" for "feet," and the value of g is 9.807 meters.

C.G.S. System.

In the C.G.S. (centimeter-gramme-second) system, space S is measured in centimeters, quantity of matter M, in grammes, time T, in seconds, and force F, in dynes, a dyne being defined as that force which acting for 1 second will give to 1 gramme of matter a velocity of 1 centimeter per second, or it is $\frac{1}{980.7}$ of the force which gravity exerts on a gramme of matter at lat. 45° at the sea level. The value of g is 980.7 centimeters.

In the C.G.S. system the word "mass" is used for quantity of matter M. In the English system the word "mass" and the letter M are used to express the quotient W/g or the quantity of matter in pounds divided by 32.174.

Definitions.

One pound of matter is the quantity of matter contained in the standard pound, a piece of metal preserved in London. One pound force is the force which gravity exerts on a pound of matter at lat. 45° at the sea level, or that force which will give to matter free to move an acceleration of 32.174 feet per second per second.

Weight.—The word "weight" is used in two senses, just as the word "pound" is, to express both quantity of matter and the force which gravity exerts on matter. If the pound force is rigidly defined as above and if the quantity of matter is determined by weighing it on an even balance or platform scale (not a spring balance) no confusion need result, for the pounds weight (quantity) and the pounds force are numerically equal to each other.

If, however, the weighing is done on a spring balance (since the force of gravity varies at different latitudes and different elevations above sea level) the apparent or "local" weight may differ as much as 1 part in 1,000 from the true weight (quantity) as determined by weighing on an even balance.

On account of the ambiguity and double use of the words weight and mass, both of these words have been omitted in the above elementary discussion of the subject.

ALL-YEAR SESSION, INDIVIDUAL INSTRUCTION: RENEWED SUGGESTIONS.

BY W. G. RAYMOND,

Dean of the College of Engineering, University of Iowa.

Ten years ago the writer made his first plea for a radical change in engineering school practice, principally advocating two things: (1) all-year sessions with brief and somewhat regularly arranged vacation periods; (2) individual instruction so arranged as to permit a student or a small group of students to advance through the course as rapidly as their ability and industry would allow.

The suggestions met with derision at that time—almost universal derision. But one by one some of the strongest opponents of the proposed change have become its advocates at least in part; and from time to time as various criticisms of present methods have been presented to the Society, the writer has reminded the Society that the cure lay in the adoption of the suggestions of 1901.

The writer has never been able to try out the experiment of an all-year session, but he has been able to experiment with the individual method of instruction. The success of the experiment has been told before this Society.

To the knowledge of the writer three schools have adopted the all-year session plan—the Thayer School of Civil Engineering in Dartmouth College, the University of Chicago which had adopted it (although unknown to the writer) before his suggestions were made, and the University of Cincinnati in connection with its coöperative courses in engineering.

Criticism of the engineering schools has not been wanting during all these years, but this criticism has not been confined to engineering schools but has reached pretty much all schools of higher education as a class; and, while the writer recognized the splendid work that has been done by the better men

who have graduated from various technical schools, he is still of the impression that these schools are not efficiently conducted and that we as a Society pay too much attention to small details of teaching and laboratory arrangement, etc., and not enough to the greater problems of general organization and administration.

The Thayer School of Civil Engineering is essentially a graduate school of engineering lap-jointed (to use one of Professor Jackson's expressions) with a course of arts. The coöperative system of Cincinnati is not suited to all or even the majority of universities, and it is probably safe to say that it is limited in the extent to which it can be developed in Cincinnati.

Admitting for the moment that some of the criticism of the engineering schools is well-founded (and the writer believes that some of it is well-founded), the difficulties cannot be met everywhere by the Thayer School method nor by the coöperative method of Cincinnati. But the writer believes that practically all the difficulties that really exist can be met by every institution by the adoption of the two suggestions made in 1901, namely, an all-year session and individual or small group instruction.

Whether or not one or more years of the course shall be devoted to practical work in a commercial establishment as is the custom in some foreign schools or whether the school shall complete its work with the young man before he enters commercial life at all, are matters of detail, as is the arrangement of the course to fit the seasons, climatic conditions, the needs of students who must be in part or in whole self-supporting, ideas of sequence of subjects, and other matters.

It is true that in some structures certain details must be designed before it is known that the proposed design for the structure as a whole is feasible. But the writer thinks that this is not true of his proposed school structure.

Engineering is now recognized as a learned profession and much more is demanded of the engineer both professionally and socially than in former years. To meet the increased

demand he must have a broader training than would suffice fifteen or twenty years ago. This means that he must take more time for his educational work either by taking more years or by making his school years longer than they now are. The writer thinks that it is better to increase the length of the school year than to increase the number of years.

The charge is made, and it is true, that there is less of personal contact between the student and experienced instructor than there should be because of the large classes that are now taught. And, while this is true to a greater extent in colleges of arts and sciences than in engineering schools, it is nevertheless true to a greater extent than it should be in technical schools. This difficulty is met by the individual or small group method of instruction.

The all-year session and individual instruction methods being thus able to meet two of the principal criticisms leveled at engineering schools, it has seemed to the writer that the time has come to repeat the suggestions of 1901, and to ask the members of the Society to consider them carefully and to give voice to the opinions resulting from such consideration.

The writer is fully aware of the radical character of these suggestions, but he is fully convinced that the weaknesses in our present systems are not to be corrected by minor operations, but that a radical change of some kind must be made if any great degree of improvement is to be accomplished. And with all the criticism and all the discussion we have had during the past ten years he has heard no suggestion made that appealed to him as being so likely to improve faulty conditions, if adopted, as the suggestion of the all-year sessions and the individual method of instruction.

It is needless to answer that one or both of these will involve considerable additional expense. Such an answer should be met with the statement that we are not spending as much as we should, that the increased efficiency is worth all that it costs, and that when this is satisfactorily shown to those who supply the money the necessary funds will be forthcoming.

CHEMICAL EDUCATION FOR THE INDUSTRIES.

BY J. H. JAMES,

Professor of Chemical Engineering, Carnegie Technical Schools.

Modern chemical manufacturing has in different branches reached its present stage of development through two entirely separate channels. The manufacture of glass, pottery, varnish, paint, iron, steel, copper, and many others, all were well established long before chemistry had emerged from the darkness of alchemy, but the knowledge upon which each of these was built was entirely empirical, entirely of the "rule of thumb." It needs no particular chemical knowledge to manufacture glass, when, for example, once the fact had been discovered, that silica, sand, lime and soda or potash heated to fusion would produce an insoluble, transparent, rigid substance, capable, while hot, of being shaped into various objects of utility. This knowledge is all empirical, and since glass is really a solid solution of several silicates, extremely wide variations are possible in the proportions of raw materials used, without the product losing the essential characteristics noted above, so that the industry developed entirely in the hands of skilled artisans who accumulated a vast amount of information in connection with its various phases.

Later, when chemistry had attained the dignity of a science we see its slow but sure influence on all such "rule of thumb" chemical industries, resulting in standardization of manufacturing methods and improvements in processes, which in many cases have been almost revolutionary in character.

There is another great field of chemical manufacture which had in its history no such evolution as noted above. I refer to those chemical manufacturing processes which are the direct outcome of the chemical research that has been carried out since chemistry became a recognized science. These proc-

esses, instead of developing by the slow more or less accidental methods of the "rule of thumb" period, were the result of laboratory research, being developed in all details on a small scale before their commercial exploitation. To this group belong the manufacture of the so-called coal-tar colors, synthetic drugs, perfumes, extracts, etc.

If, then, all branches of present day chemical manufacture are dependent more or less upon chemical science for working knowledge, has this industry rewarded the chemist as is surely his due? Confining our discussion to American conditions, it would appear that such has not been the case.

The main reason seems to be that our schools have too long been training analytical chemists, and to a lesser extent research chemists for the industries, not recognizing the fact that what the manufacturer wants in ninety per cent. of the situations offered, is a man with a combined chemical and engineering training.

The research chemist has an important place to fill in the modern industrial scheme, but in point of numbers, naturally, more operating chemists are needed; in fact, the ideas and the processes worked out by one good research chemist will keep dozens or even hundreds of operating men or chemical engineers at work, designing, installing and operating the apparatus needed for carrying out the processes on a large scale.

The important problem before the educator, in this connection, is the training of that relatively new product, the chemical engineer, as the courses and post-graduate work for students intending to follow research are already well worked out in European and American universities. A four-year course in pure and applied chemistry, without engineering, such as is offered in some American technical schools, might serve as a preparation for research work, but is not as good as the above.

Although all industries based on chemical reactions need the analytical chemist, as manufacturing methods become standardized, analytical methods as well are clearly worked out. Analytical work in most cases can be turned over to men

of little training or even to boys, all working under the supervision of a trained chemist or chemical engineer, who has in addition to the analytical laboratory the supervision of operations in the plant. So, in our opinion, we should make the training in analytical chemistry incidental only to its connection with either research or operating work in industrial chemistry. Analytical chemistry is a tool to be used by the industrial chemist, just as mechanical drawing is the important tool of the mechanical engineer.

In the arrangement of the chemical engineering course about equal emphasis should be placed on chemical subjects on the one hand and engineering fundamentals on the other. Since the engineering subjects must be taught as minors in the mechanical, electrical and civil departments, the success of the chemical engineering course depends on the coöperation of these other departments. Interdepartmental jealousies and friction lower the efficiency of a school as a whole, and the injury from these causes falls with particular weight upon such a course as that of chemical engineering.

Since it is manifestly impossible to give extended training in mechanical, electrical and civil engineering in four years, together with a good chemical education, the arrangement of these minors deserves very careful consideration.

In general, it may be said that our chemical engineer's knowledge of mechanical, electrical and to a certain extent of civil engineering, can not extend any farther than the elementary principles of design, with greater stress laid on the operation and maintenance of apparatus in each field.

In the mechanical engineering minor for example, there should be given the elements of machine design, so that the student can, if necessary, design the simpler machines used in chemical manufacture. While we would not desire that our chemical engineer should be able to design a steam engine, he should be able to understand all the points involved in its care and operation. The chemical engineer is not a specialist in the design of pumps, blowers or meters, but he should

have sufficient general knowledge in this field to intelligently select, order and install all such apparatus.

In like manner, the embryo chemical engineer does not take up the details of dynamo, motor and transformer design in electrical engineering, but he should have a sufficient knowledge, for example, of electrical machinery, to order the proper dynamos, transformers and connections for an electric furnace installation required for carrying out a certain electro-thermal reaction on a large scale.

Invaluable, in the training of the chemical engineer, is a course in shop management, when the school in question is fortunate enough to have a competent man on the faculty, who has had practical experience in industrial systematization.

This leads to the thought that the men giving instruction on the chemical staff, and in the various engineering subjects, should be identified with the industries of the locality. This is particularly applicable to the chemical profession, since here, deplore it as we may, there exists a great deal of the foolish harboring of secrets that characterized the old alchemical days, which prevents the publication of improvements in apparatus and processes for years and years. The professor of applied chemistry and chemical engineering who depends on published books and periodicals for information for his lectures will be teaching practice that is twenty years behind the times. He should have a wide acquaintance among men in chemical engineering and should be allowed to have his schedule arranged so that from one third to one half of his time is available for consulting work that will bring him in close touch with one or more live chemical industries.

With coöperation in the teaching of the engineering minors as noted above, and with men of strong personality on the chemical staff of an institution, who love equally well their teaching and consulting work, the student of chemical engineering will have created for him an interest in his profession that will carry him forward to a successful career.

GRADUATE COURSES IN HIGHWAY ENGINEERING AT COLUMBIA UNIVERSITY.

BY ARTHUR H. BLANCHARD,

Professor of Highway Engineering, Columbia University.

The status of highway engineering in the United States was ably presented before this Society at the New York meeting in 1909 by the Hon. Logan Waller Page, Director of the United States Office of Public Roads. As stated by Mr. Page, many years will elapse before the supply of thoroughly trained highway engineers will exceed the demand. The conditions existing in 1909 have not been materially improved during the past two years.

The technical graduate who is attracted to highway engineering has several more or less well defined fields open to him, namely: the highway departments of municipalities and towns; those of states, counties and parks; the engineering organizations of contractors; and the engineering and sales departments of companies dealing in materials and machinery used in highway work. In city and town work, matters relative to the construction and maintenance of streets and pavements compose the bulk of the work assigned to the highway departments together with more or less road engineering problems. With state, county and park departments, the construction and maintenance of all types of road surfaces and bituminous pavements constitutes ninety per cent. of the work of such organizations while certain problems in street pavements and highway bridges have to be dealt with occasionally. The prevailing idea, however, that the two fields just mentioned are easily separable and that the preparation for one should not be the preparation for the other is essentially wrong. Since the lines of demarcation between the

above fields are rapidly becoming obliterated, the successful highway engineer of to-day, whether engaged by the city or state, must have a comprehensive knowledge of all branches of highway engineering and allied subjects. Otherwise it is obvious that it will be impossible to follow that important principle of economics of highway engineering, the adaptation of methods and materials to local conditions.

In contemplation of these opportunities, the essential prerequisites of a successful career as a highway engineer must be given due consideration in order that the future prospects offered by this field of engineering may be thoroughly understood.

The ideal foundation consists, first, of four years' training in a course in civil engineering; second, practical experience in both field and office in connection with the construction and maintenance of roads and pavements on a system of highways; and, third, the acquisition of knowledge along certain lines of particular value to the highway engineer.

In explanation of the last prerequisite it might be stated that to be well informed the highway engineer must acquire considerable knowledge relative to the economics of highway engineering, materials of highway engineering, management engineering, highway laws and systems of administration, mechanical appliances used in highway engineering, highway bridges and culverts, road and street surveying, drafting and designing, methods used in a road material laboratory, advanced dynamic and structural geology, lithology, petrology and petrography, processes of industrial chemistry, methods of testing bituminous materials and the interpretation of results, and finally, advanced highway engineering covering the most recent practice throughout the world in the construction and maintenance of all kinds of roads and pavements.

The fulfillment of the first two prerequisites mentioned is easily accomplished except that the graduate of one or two years' standing may with difficulty retain his position during the months from December to March inclusive, especially if he is connected with a state or county department or the organ-

ization of a contractor. In these fields of highway engineering the immense amount of work to be completed during the construction season in the north requires the maximum engineering force obtainable both in the field and in the office, while during the four months mentioned above, the natural confinement of a large percentage of the work to the office necessitates reducing the engineering staff. The prospect of being without work for four months of the year has prevented many high-grade technical graduates from entering the field of highway engineering. In certain cases it has been possible by coöperation between state highway departments and colleges giving courses in civil engineering to mitigate the evils of this situation. As a concrete example may be cited the writer's experience while he was Deputy Engineer of the State Board of Public Roads of Rhode Island. Many of the best civil engineering students at Brown University were employed throughout the college year part time and during vacations all the time, year in and year out, with the natural result that upon graduation some became members of the permanent force. At all times, however, the office force consisted of trained men of a number commensurate with the work of a given season. It should be said that in many cases this plan will not work out satisfactorily for the field or inspection force, due primarily to the fact that while the construction season extends from April to November inclusive in certain sections of the country, the long vacations cover only June to September inclusive, hence the impracticability of utilizing undergraduates, resident at the University, in the months of April, May, October and November in the above field positions.

The third prerequisite mentioned might, of course, be covered by collateral reading, but it is self-evident that only a very limited idea of certain of the subjects mentioned can be acquired in this way. Especially is this statement applicable to over fifty per cent. of the subjects which, it is apparent, must be illustrated and exemplified by laboratory equipment and well stocked museums or developed through the medium

of research library work. The United States Office of Public Roads, through the medium of its corps of civil engineering students, offers a method by which a limited number of men may receive training in the construction of roads and instruction in various subjects related to highway engineering. However, as Mr. Page stated in 1909, "this plan will provide but a small percentage of the engineers that will be required."

The problem before the educational institutions of this country is that of determining by what method the subjects outlined above can be offered upon a practical basis. The writer does not favor a four-year undergraduate course in highway engineering, not only because of the varied and potent reasons which have been presented to this Society on various occasions with reference to specialized undergraduate courses, but also because undergraduate students are not sufficiently mature to acquire the benefits which should be derived from a combination of practical experience and specialized knowledge.

The most practicable plan is to arrange a definite course of instruction as a unified graduate course based on the assumption that the technical graduates enrolled for the Master's Degree will hold undergraduate degrees in civil engineering. If the graduate instruction is to be given in the period from about December 1st to about April 1st it will be possible for practicing highway engineers, especially first, second, and third year graduates, to use the winter period advantageously in acquiring advanced knowledge under favorable circumstances.

It is gratifying to the highway engineering profession and that portion of the public interested in the development of good roads and streets throughout the United States that Columbia University should have decided to establish graduate courses in highway engineering based upon a most comprehensive plan embodying the principles enunciated above.

The new graduate courses to be offered at Columbia next year will cover the field of subjects referred to previously in this paper and will in amount be sufficient to satisfy the

requirements for the Master's Degree. As the period of attendance will be from December to March inclusive, equivalent to about one semester, two periods of residence will be required to fulfill the requirements for the Degree.

The tentative arrangement of the graduate courses to be offered is as follows:

FIRST YEAR.

Processes of Industrial Chemistry,
Dynamical and Structural Geology,
Advanced Highway Engineering,
Materials of Highway Engineering,
Seminary in Current Highway Engineering Literature,
Lectures by Highway Engineers, Chemists and Other Experts,
Mechanical Appliances Used in Highway Engineering,
Highway Bridges and Culverts,
Road Surveying, Drafting and Designing.

SECOND YEAR.

Industrial Chemical Laboratory,
Lithology, Petrology and Petrography,
Advanced Highway Engineering,
Highway Laws and Systems of Administration,
Seminary in Current Highway Engineering Literature,
Lectures by Highway Engineers, Chemists and Other Experts,
Road Material Laboratory,
Management Engineering,
Street Surveying, Drafting and Designing.

As the special staff of instructors has been appointed and as the various laboratories required will be completely equipped in the near future all the advanced courses in highway engineering and allied subjects as outlined in the above schedule will be open to properly qualified persons next December.

It is of interest to note that this plan has the enthusiastic

support of many of the foremost highway officials and engineers in the United States. All emphasize the feasibility of granting four months' leave of absence to practically all the young civil engineers who wish to take graduate courses in highway engineering. It is the hope of those interested in the higher education of highway engineers in the United States that it will be possible in the near future to lay the foundation for the establishment of a corps of highway engineers comparable to that admirable body of trained men who have graduated from l'Ecole Nationale des Ponts et Chaussées of France.

ELECTRICAL ENGINEERING INSTRUCTION.

BY ELLERY B. PAINE,

Assistant Professor of Electrical Engineering, University of Illinois.

The writer will endeavor in this paper to tell how the problems of electrical engineering instruction have been solved at the University of Illinois. Here, as in all institutions, there is the problem of what to teach of the ever increasing volume of subject matter. There is also the problem of how to handle large and growing classes. This paper will be limited to a discussion of the instruction given by the department of electrical engineering to the undergraduate electrical engineering students. Some students from other departments are also given this instruction. The briefer courses in electrical engineering intended for students in other departments of the university will not be included in this discussion. It will be seen that electrical engineering instruction at the University of Illinois deals largely with the theory of electrical apparatus. But descriptive instruction is given sufficient to familiarize the student with the construction and operation of electrical machinery. The student is first given a brief general survey of the field of electrical engineering and then proceeds to a study of details. Continual repetition of important principles is given until the student has had opportunity to master them. Knowledge of mathematics is considered of highest importance. The time devoted to the study of mathematics has been increased. The tendency is to introduce more and more problems in electrical engineering requiring differential equations for their solution. At the University of Illinois all students in electrical engineering follow the same course of studies. There are no undergraduate electives offered. The instruction in electrical engineering extends throughout the junior and senior years.

Outline of the Courses.

Class-Room.—During the first semester of the junior year the students meet for class-room instruction three times a week. The remaining three semesters they meet for class-room instruction four times a week. For class-room instruction the electrical engineering students are divided into four junior sections and four senior sections. This makes about twenty students in each junior section and fifteen in each senior section. Class-room instruction is in charge of two instructors, each of whom is responsible for two junior and two senior sections. During the first semester of the junior year each instructor meets his two junior sections combined for a lecture once a week, and each section singly for recitations twice a week. For the remainder of the course he meets his sections combined for a lecture twice a week and singly for recitations twice a week. The class-room instruction, after the first semester of the junior year, does not follow a text-book closely. The student provides himself with several books of permanent value for use as reference books. The principles studied are developed in lectures. Daily problems for home solution are given. A large per cent. of these problems require numerical calculation and involve the plotting of results in curves. Lectures and recitations alternate. The method of conducting the recitations varies with the subject. Written recitations are held frequently. In the recitations the students are questioned regarding the subjects taken up in the lectures and also about the results of their problems.

Laboratory.—Each student spends one three-hour period in the electrical engineering laboratory each week of the junior and senior years. The laboratory equipment is such that it is not advisable to allow more than twelve to sixteen students in a laboratory section. It is possible to have one junior section and one senior section working simultaneously. The students in each laboratory section are divided into squads of three or four. The students forming a squad work together in their tests. Each week in turn one of the students acts as leader of his squad. The leader directs the experimental work and is

held responsible for all instruments and apparatus used. The machines are not permanently connected with the switchboard. The students for each test must make their own connections. In general the students are left to their own resources as much as possible. Each student must prepare a carefully worked out report of each experiment. In this report he is expected to answer questions printed in the directions for making the experiment. Special blank forms are not used.

Design.—Instruction in electrical engineering design is given throughout the senior year. Each week of the first semester the student attends one design lecture and spends one three-hour period in the design-room. Each week of the second semester he attends two design lectures and spends one three-hour period in the design-room. Electrical design is taught by two instructors, each of whom is responsible for about half of the students. Each instructor meets all of his students at one time for lectures. His students are divided into sections of about twelve for design-room work. The design-room work is distinctly calculation rather than drafting. No drawings are made except such sketches as are necessary to obtain measurements needed for calculations. The work in design follows closely the instruction given in classroom.

Seminar.—The senior electrical engineering students meet once each week for a two-hour seminar period. The students in turn present papers on some subject they have chosen after consultation with the instructor in charge. A large proportion of the papers consist of description of some phases of engineering construction or operation with which the students have had practical experience. After the paper is presented the subject is open for discussion, which often is animated. The student who presents the paper is expected to answer all questions or objections, and since he naturally wishes to be able to hold his own, he has a strong incentive to master his subject thoroughly. Several lecture series are given by instructors on such subjects as illumination, telephony, electric railway motors, etc.

Thesis.—Thesis subjects are assigned the first semester of the senior year. The student is supposed to do preliminary work the first semester, but the real task of thesis preparation is carried out the second semester. The students work singly or in groups according to the nature of the subject. Each thesis is under the supervision of an instructor, to whom frequent reports of progress are made.

Inspection Trip.—In October or November the senior electrical engineering students are given a carefully planned inspection trip. The time devoted to this inspection is usually three days. Under the conditions at Illinois it is believed a trip of this length yields the maximum benefit with the minimum expense of time and money.

Correlation of the Courses.

The end in view is to make the combined courses a unit, and not necessarily to make each individual course complete in itself. To accomplish this aim it is important to provide as perfect correlation as possible. The more important principles are presented from different view points in class-room, laboratory, design-room and seminar. This method emphasizes what is most important and leads the student to a more accurate understanding of the subjects so presented. The table shows the subjects taken up each semester.

Description of the Courses.

Junior Year, First Semester.—The class-room instruction follows a text-book closely. Much emphasis is placed on the fundamental laws which are the basis of electrical engineering, and considerable time is devoted to descriptive teaching concerning the construction and operation of the more common pieces of direct and alternating current apparatus. The student is given thorough drill in the solution of simple direct current problems. Dynamo models and parts of machines are used as an aid in teaching construction details. Demonstration lecture experiments are performed before the class as an

aid in the study of the operation of direct current generators and motors. Problems are assigned based on data obtained in the lecture experiments. When feasible, class-room experi-

Semester.	Class-room.	Laboratory.	Design-room.
Junior year. First.	Fundamental laws. Electric circuits. Construction of D.C. & A.C. apparatus. Operation of D.C. generators. Operation of D.C. motors. Magnetic circuits. Storage batteries.	Study of D.C. circuits. Operation of generators and motors. Characteristic curves of various types of motors and generators.	
Junior year. Second.	A.C. wave forms. Vectors. Complex quantities. A.C. circuits. Transmission lines. Transformers.	Study of D.C. generators and motors. Determination of wave forms. Study of A.C. circuits. Measurement of power. Study of artificial transmission line.	
Senior year. First.	Transformers. Wave analysis. Three-phase circuits. A.C. generators.	Transformers. Poly-phase power measurements. A.C. generator tests. Parallel operation of D.C. generators and A.C. generators. Photometric tests.	Transformer. D.C. generator. Alternator.
Senior year. Second.	Synchronous motor. Induction motor. Distributed inductance and capacity. Synchronous converter. Transient phenomena. Commutator motors.	Storage battery. Synchronous motor. Three-phase transformers. Induction motors. Synchronous converter. Arc lamps. Integrating wattmeter.	Alternator. Induction motor. Electric power plants. Illumination. Electric drives. Systems of distribution. Synchronous converter.

ments are made at a later date to show the students how closely their calculated results compare with the actual quantities. In the study of magnetic circuits the student makes

calculations for several problems, including that of finding the saturation curve of a direct current generator from the dimensions of the machine. A few lessons are given to a brief study of storage batteries.

The experiments performed by each student in the electrical engineering laboratory the first semester of the junior year include the following:

Study of series circuit.
Study of series and parallel circuit.
Measurement of resistance by fall of potential.
Variation of resistance with temperature.
Starting and reversal of motors.
Static torque test of motor.
Brake test of shunt motor.
Brake test of series motor.
Magnetization curve of generator.
Characteristic curves of shunt generator.
Characteristic curves of compound generator.
Stray power test of a motor.
Speed control of motor by field rheostat.
Speed control of motor by armature rheostat.

Junior Year, Second Semester.—In the class-room the lessons for the first few weeks deal with the subject of alternating wave forms of voltage and current. The subject is developed by lectures and graphical problems. The student determines the instantaneous values of voltage generated in a coil which is assumed to rotate in magnetic fields of uniform and also non-uniform distribution, and plots these values to rectangular coördinates. In these problems the magnetic flux is represented by lines drawn on paper, and the voltage at any instant is taken as proportional to the rate of change of lines enclosed by the coil. The influence of magnetic distribution on wave shape is clearly brought out by these problems. The student learns the effect on wave form of distributing the winding by finding the voltage wave for the case of two or more coils in series with phase displacement of ten or fifteen degrees. The approximate wave form of an alter-

nator with chamfered pole tips is found by the student. A projection oscillograph constructed by students is available, by means of which wave forms of voltage and current may be shown on the lecture-room screen. The student then considers the relation between voltage and current in a circuit containing resistance only. He is asked to determine the relation between current and voltage in a circuit containing resistance and also containing a coil. From his knowledge of fundamental laws the student is able to determine the influence of self-inductive reactance for any wave form of current, assuming constant reluctance for the magnetic circuit of the coil. In a similar manner he is led to work out for himself the influence of capacity reactance. The graphical problems performed and the wave forms plotted aid in making clear the meaning of the terms used, such as phase relation, cycle, etc. The distinction between effective and average values is discussed, and the student finds the relation between maximum, effective and average values for several of the wave forms represented in his problems. The subject of electric power in single-phase circuits is studied by assuming sine waves of voltage and current and plotting the power wave. The students assume various phase relations of voltage and current and learn not only that electric power is of double frequency but the relation between voltage, current, phase-angle and power. The student also solves a similar problem with a balanced two-phase circuit and discovers for himself that the total power is constant.

The differential equations for a circuit containing resistance, inductance and capacity are developed and the student obtains the solution for the case of a sine wave of current. The student finds this solution corroborates his graphical solutions. He also learns the numerical relation between reactance and inductance or capacity. The various methods of representing alternating vectors are studied. The method adopted for use is that of the polar time diagram. Steinmetz's symbolic method of calculation is taken up. To afford practice in the use of this system, also to make the student's

understanding of circuits more complete many problems dealing with series and parallel circuits are assigned. Vector diagrams for all problems are drawn by the student in order that he may learn the connection between the algebraic expressions and the geometric representations of the same. As an example of alternating current curcuit the transmission line is studied in detail, and many numerical problems are given. The student is taught to arrange his numerical work in tabular form, also never to depend on a single calculation but to carry out the result for several cases with slightly varying conditions. These results should plot in a smooth curve if there is no numerical error in any of the calculations. The student also becomes familiar with the per cent. method, which he finds of great advantage. In this method full load voltage and full load current are taken as unity or one hundred per cent. The value of resistance or reactance is taken as the per cent. of full load voltage required to pass full load current through the resistance or reactance. These per cent. values are used in the calculations in place of the values of volts, amperes and ohms.

The transformer is easily understood by the student after his study of self induction. Lecture experiments are performed to illustrate the law of ratio of turns, the phenomenon of magnetic leakage, the influence of joints in magnetic circuit on core loss, magnetizing current, and magnetic leakage. The question of reactance is discussed, and by experiments the influence of relative position of coils on reactance is shown. The method of representing a transformer by an equivalent circuit containing resistance and inductance is developed. From the transformer constants derived from the lecture experiments the students make calculations to determine the influence of secondary load and power-factor on the transformer efficiency and regulation.

The experiments performed in the electrical engineering laboratory the second semester of the junior year are as follows:

Compounding of shunt generator from magnetization curve and external characteristic.
Armature characteristic of shunt generator.
Magnetic distribution in air gap.
Rating of motor for measurement of power.
Determination of wave form by Mershon's method.
Determination of wave of magnetic flux.
Study of series circuit containing resistance and inductance.
Study of parellel circuit containing resistance and inductance.
Value of current and phase-angle in a circuit of varying inductance.
Value of current and phase-angle in a circuit of varying frequency.
Effect of frequency on indication of ammeter.
Measurement of power in single-phase circuit by wattmeter.
Study of artificial transmission line.

Senior Year, First Semester.—In the class-room a brief review is made of the ground covered in the preceding semester. Transformer operation is studied by means of curves showing the instantaneous values of voltage, current and flux plotted to rectangular coördinates. The student is given data for the hysteresis loop of a transformer and finds the flux and current waves assuming a sine wave of voltage. He also finds the flux and voltage waves assuming a sine wave of current. The student is taught how to analyze waves, and he finds the harmonies present in his waves of transformer exciting current and voltage. A series of problems is assigned to determine the relative importance, as regards efficiency and regulation, of the four transformer constants: core loss current, magnetizing current, resistance and reactance. Values of constants for a good transformer are given. Each student considers three of these constants fixed and calculates, for some particular load power factor, the efficiency and regulation of the transformer with a wide range in value of the

fourth constant. Results are given out by students in class and are plotted in curves on the black-board. This method has the advantage of lessening the tendency of students to copy the work of others, and also affords interesting and valuable material for class-room discussions. The methods of measuring three-phase power are studied. The question of harmonies in three-phase systems is discussed. The influence of harmonies on three-phase transformer operation is investigated. A study of the alternator is then made in the class-room. The alternator vector diagram is drawn and equations for the calculation by complex quantities are developed. The student learns how to calculate the reactance of alternators. The relative magnitudes of reactance to be used for energy and for wattless current is discussed. The student learns how to calculate the armature reaction for machines with and also without definite poles. A group of problems is assigned, the solution of which shows the class the influence on the operation of an alternator, of changes in the proportions of the teeth and changes in length of air gap.

The experiments performed by each student in the electrical engineering laboratory the first semester of the senior year are as follows:

Methods of connecting coils of single transformer.

Reactance of a coil containing iron in its magnetic circuit with various values of current.

Determination of reactance drop of a transformer under load.

Efficiency of a transformer by stray power method.

Calculation of regulation of a transformer from no load readings.

Determination of hysteresis loop of a transformer.

Measurement of poly-phase power by one, two and three wattmeter method.

Ratios of voltages and currents in Δ and Y connected transformers.

Separation of iron losses of a transformer.

Determination of Steinmetz's coefficient and exponent.

Characteristics of incandescent lamps.
Determination of distribution curves of incandescent lamps.
Measurement of D.C. and A.C. arc lamps by reading illuminometer.
Open circuit saturation curve of an alternator.
Synchronous impedance of an alternator.
Parallel operation and load division of shunt and compound D.C. generators.
Parallel operation and load division of alternators.

In electrical engineering design the first semester of the senior year the time is devoted entirely to a study of the design of electrical machines. In the lectures the methods of design are taken up. The student makes calculations for the following:

Design of a transformer, single-phase and poly-phase.
Design of a direct current generator.
Design of an alternating current generator (started).

Senior Year, Second Semester.—In the class-room the vector diagram for the synchronous motor is developed and equations derived for the calculation by complex quantities. Constants for a synchronous motor are given and the student calculates its characteristic curves. Problems are assigned which show the influence of varying loads on synchronous motor stability. The students make calculations which show the use of the synchronous motor in voltage control of distributing systems.

The induction motor is studied in a similar way and the students solve a carefully planned series of problems. These calculations make it possible to bring out clearly the important features of induction motors.

A few lessons in mathematics are given to review the differential equations which appear frequently in engineering problems. The students make calculations of long distance transmission lines, assuming distributed inductance and capacity. They also solve several problems involving the transient phenomena of starting or stopping currents.

The synchronous converter is discussed. Several problems are assigned involving the calculation of voltage, current and heating ratios of synchronous converters.

The theory of commutator alternating current motors is developed and each student calculates from assigned data the characteristic curves of a series alternating current motor.

During this semester frequent written quizes are held covering all the student has studied in electrical engineering.

The experiments performed by each student in the electrical engineering laboratory the second semester of the senior year are as follows:

Storage battery test.
Operation of synchronous motor under variable load with constant field excitation.
Phase characteristics of synchronous motor.
Determination of wave form by an oscillograph.
Study of harmonics in three single transformers, three-phase connection.
Study of harmonics in core and in shell type three-phase transformers.
Study of A.C. arc lamps.
Brake test of an induction motor.
Stray power test of, and circle diagram for an induction motor.
Efficiency of an alternator by stray power method.
Study of induction type integrating wattmeter.
Starting and operation of a synchronous converter.

In electrical engineering design for the second semester of the senior year the time is devoted partly to the calculation of machines and partly to a study of power plant design. The work done by the student during the design-room periods includes the following:

Design of an alternator (started in first semester).
Design of an induction motor.
Design of a synchronous converter.

Power plant design is taken up in the lecture periods. The problem assigned this year was a power plant for the local

city. The city was divided into sections, and each student made a careful survey of one section and estimated the amount of electric power used in that section for house lighting, street lighting and power. From these estimates the load center was determined, also the estimated load curve of the station. The students were interested to find the actual load curve of the existing station differed by about ten per cent. from the estimated load curve. The best location for the plant was studied and the value of land for the different locations obtained. The size and number of generating units was discussed. Each student then made plans for the station lay-out and estimated the probable cost of the same.

The other subjects discussed in the design lectures include the following:

Water power development.

Interior and street lighting.

The application of electricity to machine driving.

Systems of electric distribution.

The student is assigned problems in each of these subjects.

The results obtained by this system of instruction have been excellent. The students are enthusiastic and show great interest in their work. One indication of this is the fact that the average attendance is found to be about ninety-eight per cent. of the number enrolled. The department believes that the mastery of the symbolic method of calculation gained by this system of instruction enables the student to get an understanding of electrical engineering theory that would be impossible otherwise. The daily solution of numerical problems gives the student valuable training in the habits of accuracy and also leads to a better understanding of underlying principles. The department is of the opinion that from the administrative point of view there is greater advantage in having all the electrical engineering students follow the same course of instruction than in having them break up into several more highly specialized courses. Since the student usually can not be sure in which part of the field of engineering his oppor-

tunity will open, it seems better for him to get thorough grounding in the general principles of electrical engineering than to specialize too fully in his undergraduate years. At the University of Illinois the graduate student in electrical engineering has abundant opportunity to pursue advanced studies dealing with any phase of the electrical engineering field in which he may choose to specialize.

THE TECHNICAL GRADUATE FROM THE POINT OF VIEW OF THE MANUFACTURER.

BY MR. E. B. RAYMOND,

Vice-president of the Pittsburgh Plate Glass Company.

I make these few remarks on this subject realizing fully my lack of experience in teaching. I do not pretend, therefore, to be competent to offer suggestions for improving existing methods. What I say, however, is based on an intimate business association over a long period with graduates of the colleges in this and other countries,—somewhat over two thousand men in all.

Four of the important characteristics in a young man are character, health, ambition and specific training in line with the work to be followed. I presume inheritance and home influence have the most to do with the first three, although undoubtedly the college has a tremendous influence, too, though not as much as with the last one.

To me, it seems absurd to expect a college in four years to turn out men freed from their natural weaknesses, when one considers the quality of the average human being who enters. It is impossible to produce, during four years, a technically-trained man with all the practical experiences that are essential for the proper assumption of authority in actual life. The average boy who enters a college requires tremendous development. It has been my experience that perhaps ten to fifteen per cent. of the graduates are of the highest class, embodying all that one could reasonably expect. About sixty per cent. of the men can be used for various positions and thirty to forty per cent. are unsuitable. Considering humanity as we see it, these figures are perhaps better than one might think. Presumably one of the vital questions under consideration constantly is how to improve the output.

Possibly it would pay to cite the undesirable characteristics which have been forced on my notice, that seriously interfere with the efficiency so generally desired.

One of these is laziness, a desire to get along comfortably, freed from as much mental or physical exertion as possible. It is hard for me to say what the college can do to alter this. If such men are dropped, the quality of the graduate will naturally improve. On the other hand, those dropped would lose the training and its help. From the point of view of efficiency of the graduate, such men should properly not receive a certificate.

Perhaps somewhat allied to the above, is the fact that many men are not willing to learn the practical end of the business they are entering. They are often unduly impressed with the immediate value of their education, and do not realize at all their unfitness for responsibility, and are not willing to make the sacrifice of time and comfort to complete their training. I have found this sometimes true of the best of men. Without this experience, which they lack, they go on for a while, but the handicap eventually holds them in inferior positions, and they never, probably, know why other men get the responsible positions, even without the complete technical training they themselves possess. The college would help if it could teach this feature and accentuate it by requiring during the summer vacations practical work in practical manufacturing institutions. I am quite certain that what I cite cannot be learned in a college workshop, although I am not prepared to state that these are not of value. It is possible that the possession of a few teachers who themselves have been successful practical men, with manufacturing responsibilities, would help.

Somewhat allied to the above, is the characteristic very positively noted with graduates, which is a remarkable lack of ability to assume responsibility, or even to carry out carefully instructions received. In other words, they cannot be trusted. There is a lack of seriousness in their point of view. They apparently do not know that a small duty well done

has in it all the virtue of a big duty. I believe the college is partly responsible for this condition. During the course, the percentage of "good time" is perhaps too great. The view of the college life might properly look more like the view of the business office. It is my feeling that the college with a minimum amount of "college life," as generally interpreted, and a maximum of "office atmosphere," produces the best material. I do not believe in college life as popularly interpreted, and would cut it down to a minimum, replacing with "office spirit."

Another feature that is noticeable in graduates, is the lack of ability to become a part of the working man's life, and to get his point of view, and thus be able to properly guide him later on. This property is an important part of the practical training, spoken of previously. Often men will get one part without the other. Some men by nature, can never get it; others can if they appreciate the need. Possibly the average young man has never had this subject properly presented to him. Perhaps a short course in the senior year on subsequent and necessary training to complete the college course, would be worth while. Such a course to be given by an outsider of special breadth of experience.

Another matter that is not properly impressed upon all graduates is the fact that what they have learned is but a small part of what is necessary for their profession, and that regular study must be kept up. I have found that the average student ceases to study for several years after graduation. This tends to make him forget what he has learned and does not keep him up with his profession.

Another duty that the college does not always fulfill is the preventing of men from taking up a profession for which they are by nature entirely unsuited. I think the college could do better in this. The average young man does not know for what he is best suited. I have found this true of the average graduate, let alone the boy entering college. To me, it is not fair to the boy to leave it to him. It disturbs me to hear a parent say that the choice of life work is to be left

with the boy. He is incapable of judging, with his lack of knowledge of life's requirements, of his own possibilities. Perhaps a college could have a committee to advise parents on this subject; or at all events, to go on record on the matter, weighing all the facts; the father's business, his circumstances, the boy's own view, and make-up. Perhaps a broad gauged practical outsider or two would be of advantage on such a committee.

Finally, and particularly, the graduates are not thoroughly trained in all the branches they have taken up. In general, there is not sufficient thoroughness in such essentials as mathematics, mechanics, and physics. The foreign colleges of Sweden, Germany and England, judging by the graduates with whom I have dealt, do better. It is possible that we try to teach too much, and therefore a great deal becomes imperfect. Perhaps the only solution is to drop some of the courses and be more thorough with those that are left. From the point of view of the young man who wants a general view of the studies of the world, or to know in a superficial way, what are the problems and records of the world, this would be a restriction. His interest would be stimulated in fewer directions, and he would be in a sense, narrower; but from the point of view of efficiency in the line he has chosen to fit himself to make the best fight, I would urge a great deal more thoroughness, more depth, and less width if necessary, to accomplish this. In saying this, I appreciate the many disadvantages, but for the purpose in view, I do not see how it can be avoided. The line of study which is omitted must be taken up by the man himself at a later time.

I hope it is not true that there is a desire in our colleges to be the largest, with the largest list of subjects taught, and the greatest publicity through athletics, etc. I hope nothing exists due to the spirit of the times which is causing a departure from quiet, earnest, business-like conduct along definite lines for a definite purpose. It is not proper to criticise without proper facts at hand; but, the thought has occurred to me, that it is possible that harm is being done in

some cases from this cause. I do not wish to be interpreted as not being fully appreciative of the great value being done to this country by our colleges. Many a man owes his position, his happiness, and his faith in himself to his college influence. The college-trained man is essential for progressive organizations. Undoubtedly the large group of rare men who are studying this problem are guiding it in the correct general direction. It must be an inspiration to know what is generally admitted, that at present, there are more positions for the right type of properly trained college men, than there are men to fill them.